

Experimental and Research Station,

Nursery & Market Garden Industries'

- - Development Society, Limited, - -

Turner's Hill, Cheshunt, Waltham Cross, Herts.



Second Annual Report, 1916.

Director—A. B. LISTER, D.I.C., B.Sc.

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Experimental and Research Station.

LABORATORY STAFF.

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Laboratory Attendant (part time).....	Helen Marchant.
Assistant (part time)	Ellen Foster.

GLASSHOUSE WORKING STAFF.

Foreman	*A. A. Richards. †T. W. Thorne.
Cucumber Grower.....	*A. H. Boatman. †J. Smith.
Tomato Grower	*T. Strutton. †F. Lowert.
General Assistant	*H. Smith. †D. Schilperoort.

*Away on National Service.

†Ineligible for Military Service.

Director's General Report.

IN presenting the Second Annual Report of the Experimental and Research Station, which has been established for the benefit of the nursery and market garden industries under glass, a brief outline of the scope and aims of the work being undertaken will not be out of place.

The Station being solely devoted to the elucidation of the many problems to which the growth of fruit and vegetables under glass gives rise, it is very necessary in drawing up a scheme of work to bear in mind two features which fundamentally differentiate the glasshouse industry from the ordinary farming industry studied at the various Agricultural Experiment Stations.

In the first instance, the nurseryman is out for fruit and not for total plant growth. Thus in tomato growing he does not aim at a heavy growth of leaf and stem, but at a large crop of fruit; indeed, he considers excessive growth of leaf and stem as detrimental.

On the other hand, the farmer, growing roots, grass, clover, cereals, &c., wants heavy growth; even in the case of wheat, where grain is the chief consideration, the straw is also a valuable commodity to be increased as much as possible. It thus differs from the leaves and stems of tomatoes, cucumbers, grapes, peaches, &c., which at present have no market value.

Secondly, the industry being carried out under glass the grower is able to control the temperature and water supply; the only important physiological factor which he does not control is the light. Thus temperature and water supply, which are often the limiting factors in ordinary agricultural work and to a large extent outside the control of the experimenter, become under glasshouse conditions important subjects for investigation; and light, which is never considered in agricultural investigations, becomes an important limiting factor.

These two considerations show that the investigations at the Experimental and Research Station must not follow too closely the lines adopted at the Agricultural Experiment Stations, but must differ from them in (a), taking more account of the qualitative plant growth which might affect the fruiting, and (b), recognising light, temperature, and water as factors influencing the growth and habit of the plants. It is convenient to divide the work into three classes, corresponding with the three stages of growth of the plants.

1.—The early stage, as seedlings and in small pots.

Probably the most important feature here is the type of growth; growers recognise a "hard" growth and a "soft" sappy growth, the latter being commonly considered of less value for fruit production. The conditions under which each can be got are well known to the grower, but it is very desirable that they should be better characterised than they are at present, and that the relationship between habit and conditions of growth should be more closely studied. There are probably two or more types of "softness," according to whether it is chiefly induced by over-watering or over-manuring. Fortunately the "hard" and "soft" types of growth are sufficiently sharply contrasted to afford a suitable basis for experimental work. The habit of growth owes its importance to the two circumstances that (a), "soft" growth appears to be more susceptible to disease than "hard" growth, and (b), that under certain conditions it is less conducive to fruiting. There are certain discrepancies in the observations so far, arising from the variations in the type of "softness" and these require elucidation.

2.—The later stages, in large pots or borders.

At this stage it is important to investigate the influence on plant growth of the various plant nutrients, nitrogen, phosphorus, potassium, &c. (See Table XIII.), in conjunction with the effect of the physiological factors such as light and temperature (See Table V.), humidity, water supply (including a study of the effect of hard and soft water), air supply to roots, and the physical nature of the soil due to liming and chalking (See Table I.), &c. The qualitative differences in plant growth at this stage require special attention, especially those associated with peculiar physiological conditions, such as chlorosis, mosaic leaf disease, &c., and with variations in the susceptibility to bacterial and fungus diseases and insect attacks.

3.—The fruiting stage.

The conditions that make for fruiting require investigation. A good deal of work has been done on fruit trees, and has shown that this subject is very difficult, but the problem at the Experimental and Research Station is much simplified by the circumstance that results can be obtained in a few months instead of having to wait for years. The main problems are those involved in the relationship between vegetative growth and fruiting, and include the influence on fruiting of temperature, light (See Table V.), food supply (See Table XIII.), water supply, extent of plant growth, and checks such as stopping (See Table XIV.), pruning, &c. At the same time it will be necessary to carry out botanical and chemical investigations of the translocation of food materials from the leaves

and stems to the fruit, and of the changes which occur during the development and ripening of the fruit. A study of these problems might be expected to lead to an investigation of the much more difficult but very important problem of quality in fruit.

Soil Problems.

The investigation of soil conditions forms an integral part of the preceding investigations. In addition there are certain soil problems that require special attention as follows:— (a). An investigation of the soil population in relation to plant growth. Methods for the study of bacteria and protozoa have been worked out at Rothamsted. Fungi and eelworms would no doubt prove amenable also, and the Myxomycetes while presenting more difficulty would have the charm of greater novelty. (b). Studies of the biochemical changes in glasshouse soils, notably the production of ammonia and nitrates and the loss of nitrogen. There are good reasons for supposing that the wastage of nitrogen is very considerable, and that great economies could be effected if it were better understood. (c). Investigations of "sickness" and sourness in soils, and the effects of partial sterilisation of glasshouse soils.

The nature of the soil at the Station, due to its virginity at present, makes it unsuitable to conduct sick soil experiments there except in pots, but the Committee of Management has made arrangements with a few local growers to treat some of their houses and to keep the results under observation during the coming season. These experiments will be correlated with pot experiments at the Station using the same soils, varieties and materials.

Pests and Diseases.

For the sake of completing the programme a section on plant pests and diseases is added. It seems clear, however, that little progress can be made in this direction until some of the preceding investigations have been carried out. Black Stripe in tomatoes is a suitable subject for experimental study, and was under investigation during last year. Until further experiments have been carried out this year no announcement can be made on the matter. This class of work cannot be confined to systematic description, but must be extended on ecological and physiological lines.

Having indicated the lines on which the investigations at the Experimental and Research Station are being conducted, I will now give a report on the work actually in hand.

During the year 1916 I received and answered 151 enquiries relating to diseases of plants, soil management, manuring, soil sterilisation, spraying, fumigation, seed testing, &c., and in connection with this work paid 51 visits to nurseries in several districts of England. The number of visitors to the Station from all parts of the Kingdom has exceeded three hundred in the year. During the first week of May, 1916, a special series of demonstrations on the work in hand was given, to which the local growers were specially invited, and about 60 availed themselves of the opportunity.

The experiments conducted last year fall into three classes:—with tomatoes in pots; with tomatoes in the ground; and with cucumbers in borders; the plants being grown under glass at all stages.

Tomatoes in Pots.

The problems under investigation were:—(a). What is the effect of lime on the growth of tomatoes in pots, and how does it compare with chalk? (b). What is the effect of straw manure? These two problems are of very great importance to growers, the marked variations in practice showing how diverse are the opinions held, even in the same district. Lime is largely used by growers with the double object of killing pests and sweetening the soil. The experiment was started with the purpose of ascertaining the relative importance of these effects, and to see how lime and chalk would act on virgin soil free from pests. In each case a number of plants were grown under conditions which were identical in all respects except one, viz.:—the quantity of lime, chalk or straw manure as the case may be. The smallest quantities used were less than most growers adopt, and the largest were more, so that all the variations used in practice were covered. The experiments in the case of lime and chalk were made with two types of soil:—the light sandy loam of the Station, and a heavy clay loam from the Waltham Abbey district; and in the case of straw manure with the Station soil only. The results have been remarkable. Although the soils in the beginning contained practically no lime, the addition of lime and chalk was almost without effect on the crop. (See Table I.) Should this result be substantiated by further trials it would indicate that the tomato does not require any large amount of lime in the soil, and that the benefit of the lime is largely as an insecticide and sweetening agent. This experiment will be repeated another year both in pots and borders. In the experiments with straw manure, considering that the amount of manure varied from five to fifty per cent., the series came out very uniform. (See Table II.) This experiment will also be repeated in both pots and borders. (c). What is the effect of

"Humogen" on tomatoes in pots? This experiment gave a negative result both last year and the year before and the series has now been discontinued. (See Table III). "Humogen" is a preparation of peat made by Professor Bottomley.

Fertiliser Experiments with Tomatoes and Cucumbers.

Our ideas of the manurial requirements of tomatoes and cucumbers grown under glass have, in the past, been exclusively derived from agricultural field experiments. No adequate allowance could be made for the difference in conditions, and therefore the advice that has been given by analysts and others always contained a large amount of uncertainty. Fertiliser experiments with these crops in our houses have shown very considerable differences as a result of the difference in conditions, and of the fact that the grower wants the fruit only and not the vegetative parts, leaves, stems and roots. These experiments will have to be repeated for some years before definite conclusions can be drawn. The following are the results of last year's experiments.

(a) With Tomatoes.

These were laid out on the old five plot system, viz.:—complete artificials alone and also with added dung, no phosphates, no nitrogen, no potash. In addition, plots were added with standard, half-standard, and double-standard dressings. The experiment was duplicated in two separate houses and the average results are rather remarkable. (See Table XIII.) The half-standard dressing gave as good a result as the standard, and a slightly better result than the double-standard dressing. The complete artificial plot without dung gave the lowest result, and the plot with complete artificials and dung was slightly below the average of the two houses. The withholding of phosphates caused some depression, but the withholding of nitrogen and potash did not have much effect last year. None of the manures produced any really notable effect. It must be remembered that the soil is virgin soil, and the results seem to be on a par with the old antagonism between vegetative growth and fruiting. Mr. Spencer Pickering, F.R.S., obtained very similar results at Woburn in his manurial experiments with fruit trees and bushes. The result is contrary to the usual experience and indicates that a marked distinction must be made between virgin soils and soils that have been in use for some time; the reason for the distinction, however, is not clear. In view of this result it is obviously necessary that proper manurial trials should also be made on old tomato soils. These experiments are being repeated this year, and two sorts are being used:—the variety "Comet," as

used last year, in one house, and another variety, "Kondine Red," which is apparently heavier in fertiliser requirements in the other house.

(b) With Cucumbers.

The cucumber experiments were on rather different lines. Three sets of borders were set up, two with and one without straw manure; those with manure containing respectively 50% and $33\frac{1}{3}\%$. The other fertilisers examined were ground hoof as a source of nitrogen and bone-meal as a source of phosphate. The borders containing $33\frac{1}{3}\%$ straw manure gave slightly better results than those containing 50%, indicating that the very heavy dressings used may not be necessary. (See Table XI.) Bone-meal retarded the crop in the case of the borders with 50% straw manure very much, and did not materially increase the amount of fruit in the borders with $33\frac{1}{3}\%$. Phosphates have been shown to depress the yields of both cotton and sugar cane crops so that our results are not peculiar in this respect. They are probably connected with the early maturity effect. This experiment is being continued and extended. Though the results indicate that some of the dressings used by growers have probably been excessive, it will be necessary to obtain very careful confirmation of the matter before any statement to this effect is published. (See Tables VIII., IX., X., and XI.)

Comparison of turf and second spit loam for Cucumber borders.

In the cultivation of cucumbers most practical growers agree that turf loam mixed with straw manure is the best compost for the borders. As large numbers of houses in the district are devoted to cucumber culture, there will come a time, as some are already experiencing, when turf *in situ* will not be available in sufficient quantity. Under the circumstances it was thought desirable to carry out a preliminary experiment to find whether turf is essential in the formation of a cucumber border, what its value is compared with second spit loam, and whether second spit loam or equal parts of turf and second spit loam could be used instead of all turf. Last year's results indicate that second spit loam or equal parts of second spit loam and turf can be used in place of all turf in making up a border. (See Table IV.) This experiment is not being continued at present, the space being devoted to more urgent work.

Physiological Conditions in Cucumber Houses.

In continuance of the first year's preliminary experiments Professor V. H. Blackman, of the Imperial College of Science and Technology, has kindly superintended some work carried

out by Mr. F. G. Gregory and the Director on the physiological conditions under which cucumbers are forced for market. Last year it consisted mainly of developing apparatus for obtaining records, both of the external conditions to which the plants were subjected, and of the physiological changes in the plants. Continuous records of temperature, humidity, and radiation were kept, and estimations were made at frequent intervals of the carbon dioxide content of the air in the houses, of the rate of assimilation, and of the rate of growth. The recording work could not be started till late in the season and most of the results were obtained during the period of June—August. As the work has been in progress for such a short time it is difficult to speak with any certainty about the results until they have been confirmed and amplified by a further year's work now in progress. A few of the more interesting results are appended.

Carbon dioxide content of greenhouse air.

Estimations of the carbon dioxide in the air of the cucumber houses were made at various times of the day and at various heights above the borders. The estimations were obtained (1), by the absorption of known large volumes of air in caustic alkali contained in a Reiset Tower and (2), by a small portable Haldane apparatus; comparable results were obtained by the two methods, and show very definitely that there is a stratification in the distribution of the carbon dioxide in the air of the houses, the content decreasing from the borders upwards. Close to the surface of the borders the amount varied from 9 to 14 parts in 10,000, while at the top of the house the amount only varied from 4 to 5 parts in 10,000, that of the outside air being 3 in 10,000. During the night the percentage at any given level is higher than during the day, as is to be expected since the assimilatory activity of the leaves ceases at night.

Rate of assimilation of leaves.

A large number of experiments were made by Sach's "dry weight" method in which the dry weight of two equal areas of the same leaf are compared before and after assimilation. The conditions which affect the rate of assimilation, *i.e.*, the rate at which the plant takes in food from the air, are numerous and the results are difficult to interpret. They clearly show that a study of the temperature of the leaf and of the stomatal aperture under varying conditions is necessary, as each of these factors is able to control the rate of assimilation. Plants under glass in a moist atmosphere are very liable to become overheated during spells of bright sunshine

so that the leaf temperature may very well be the main controlling factor.

These factors are being studied this season.

Rate of growth.

This was studied by careful measurement of the daily increments in length of a number of axillary shoots. An average obtained from these records was taken as an index of the vegetative activity of the plant. A marked relationship was found between the growth rates and the minimum night temperatures; the higher the night temperature the greater the vegetative activity of the plants. When the rates of growth were compared with the crop results it was found that periods of high vegetative activity were associated, 27 or 28 days later, with large yields of fruit. If this result is substantiated by further work it will be of considerable economic importance.

During the present season the problem of the balance between the vegetative growth and fruit production in cucumbers is being attacked from as many points of vantage as possible.

Light and temperature effects.

During the first year the effect of temperature on crop production was observed in four cucumber houses, and for this purpose each house was divided into two parts transversely. The houses run North and South, and the northern halves being nearer the boilers, and further protected by a heated corridor, always maintained a higher temperature than the southern halves more remote from the boilers and not protected by a corridor. In the first year the cooler southern halves gave at least 25% more fruit than the warmer northern ones. Last year the experiment was repeated chiefly in one house in which the heating pipes were re-arranged in such a way as to accentuate still further the difference in temperature between the two halves. The records of temperature variation in the two halves were continuous and in addition the solar radiation was automatically recorded by means of a Callendar Radiation instrument. The crop in the warmer half house was earlier but lighter in total fruit production than the cooler southern one which was later in bearing but heavier by about 9% on the total fruit. (See Table V.) This result was also borne out by two other borders with identical treatment in another house, one at the southern end and the other at the northern, both on the same side of the house, which gave total crop in favour of the southern end by 8%. (See Table VI.) The relative importance in fruit production of the factors, light, temperature, and humidity is now under investigation.

Effect of "Humogen" on Cucumbers.

Last year the borders with "Humogen" in the proportion of one part of "Humogen" to nine parts of loam gave slightly better results than the control border of equal parts loam and straw manure. (See Table VII.) The material supplied by the manufacturers, however, was unfortunately far from uniform in character. This experiment is being discontinued and the space devoted to more urgent problems.

Experiments in management and cultivation of Tomatoes.

Growers have long realised that the management of the tomato plant is a highly important factor in fruit production. They have never really decided whether or not it is best to stop the plant at four or five trusses of fruit and then let it run on, or to let the plant run straight on from the beginning. The question is one of considerable technical importance, and a house was therefore devoted to it. The non-stopped plants came out best last year with 19 out of the 25 varieties tried in favour of non-stopping. (See Table XIV.)

The setting of the fruit is perhaps the most important problem in the management, and one on which least physiological information is available. It is extremely important to know whether it is best to maintain a dry or a humid atmosphere. Two houses were devoted to the problem last year, and the house that was not specially damped gave the better results. (See Table XII.) The house in which the damping was specially done was completely partitioned off from the next one. Four varieties were grown and compared with corresponding numbers of the same varieties in similar positions in the house that was not specially damped, the manurial treatment in both houses being the same. It is possible that the character of the season would affect the result considerably.

This experiment is being repeated.

Varieties.

A house was set aside for 25 fairly new varieties of tomatoes grown under identical conditions, so that growers could see and judge for themselves how they compared. The variety tests were combined with the experiment on stopping of the plants. Eighteen plants of each variety were grown on each side of the house, one side being stopped and the other side not stopped. (See Table XIV.) This year one half of this house is being devoted to an experiment in the culture of early

potatoes under glass, one quarter to variety tests, and the remaining quarter to observation rows for collecting data from which the probable error per plant for the variety grown can be calculated. The variety being tested this year is "Comet."

Station Bulletins.

The following were issued during the year:—

1. Manuring for tomatoes in war-time. November 9th, 1916.
2. The culture of early potatoes under glass. December 18th, 1916.

These are reprinted in the Appendix.

Experimental Crop Records and Tables.

The total number of experimental plots was 135, of which 117 were devoted to tomatoes and 18 to cucumbers. Records of the fruit production were taken in each case on Mondays, Wednesdays, and Fridays throughout the season, and the produce marketed. Frequent observations on the growth of the crops were made and recorded in the Day Book. In every case the figures in the following tables refer to the total fruit in lbs. per plant to the end of the month indicated.

The following are the metric equivalents of the constants mentioned in the report.

1 acre	...	...	...	=	0.404 Hectare.
1 lb. (pound avoird.)	...	...	...	=	0.453 Kilogramme.
1 lb. per acre	...	...	...	=	1.12 Kilogramme per Hectare.
1 ton	...	...	...	=	1016 Kilogrammes.
1 ton per acre	...	...	...	=	2512 Kilogrammes per Hectare or 25.12 metric Quintals per Hectare.

Except where otherwise specified the subsequent treatment of all plots as regards watering and the general details of cultivation and management were identical in each series.

The letters and numbers in each series refer to the Second Annual Guide to the Experiments, 1916, which was distributed to all Members of the Society and visitors to the Station during the year. (Supply exhausted.)

Pot Tomato Experiments.

Isolation House.

This house, which is 80 feet long by 20 feet wide, was built separately from the other culture houses in order to provide accommodation for the investigation of tomato diseases. At present this house is being used for pot culture experiments. About 250 No. 8 (12in.) pots can be accommodated. Last year the Series A. to F. inclusive were in this house, and the variety grown throughout was Holmes's "Tuckwood Favourite." (See Tables I., II., and III.) There were 232 pots, the total yield was 0.65 ton, the average per plant being 6.4 lbs. Throughout the Series A. to F. inclusive, top dressings were given fortnightly from June 13th onwards at the rate of one ounce of Special Tomato Fertiliser per pot. (For analysis see Appendix).

Table I.**Series A. to D. inclusive.**

Pot experiments to determine the relative value of lime and chalk in tomato culture on light sandy, and heavy clay loams respectively.

Series A.—Effect of caustic lime (oxide of lime).
(Light Sandy loam from the Experimental Station).

	Total fruit to end of each month in lbs. per plant.				
	June.	July.	Aug.	Sept.	Oct.
A. 1. Control mixture of light sandy loam plus 56 lbs. straw manure, 2 lbs. bone-flour, 2 lbs. ground hoof, 2 lbs. bone-flour, and 2 lbs. sulphate of potash per cubic yard of loam. *	1.9	4.3	5.4	6.8	7.7
A. 2. Control plus 0.25 % caustic lime	2.0	4.3	6.0	7.0	8.1
A. 3. Control plus 0.5 % caustic lime	1.8	3.9	6.3	6.8	7.6
A. 4. Control plus 1.0 % caustic lime	2.0	4.4	5.7	6.5	7.3
A. 5. Control plus 2.5 % caustic lime	1.8	5.0	6.1	7.3	8.5
A. 6. Control plus 5.0 % caustic lime	2.2	3.9	5.9	7.2	8.3
A. 7. Control plus 10.0 % caustic lime	1.5	3.5	4.6	6.2	6.8
* A cubic yard of light sandy loam weighed 15.5 cwts.				Total	54.3

Series B.—Effect of chalk (carbonate of lime).
Light sandy loam from the Station.

	Total fruit to end of each month in lbs. per plant.				
	June.	July.	Aug.	Sept.	Oct.
B. 1. Control mixture of light sandy loam plus 56 lbs. straw manure, 2 lbs. bone-meal, 2 lbs. bone-flour, 2 lbs. ground hoof, and 2 lbs. sulphate of potash per cubic yard of loam	2.1	3.8	4.8	6.1	7.0
B. 2. Control plus chalk equal to 0.25% caustic lime	1.7	4.5	5.3	6.3	7.1
B. 3. Control plus chalk equal to 0.5% caustic lime	2.1	4.9	5.7	6.9	7.9
B. 4. Control plus chalk equal to 1.0% caustic lime	2.3	4.6	5.4	7.2	8.0
B. 5. Control plus chalk equal to 2.5% caustic lime	2.4	4.8	6.2	7.5	8.4
B. 6. Control plus chalk equal to 5.0% caustic lime	2.3	4.7	5.7	6.5	7.6
B. 7. Control plus chalk equal to 10.0% caustic lime	2.2	4.5	6.0	7.1	7.7
				Total	53.7

Series C.—Effect of caustic lime (oxide of lime).
(Heavy clay loam from Waltham Abbey).

	Total fruit to end of each month in lbs. per plant.				
	June.	July.	Aug.	Sept.	Oct.
C. 1. Control mixture of heavy clay loam plus 56 lbs. straw manure, 2 lbs. bone-meal, 2 lbs. bone-flour, 2 lbs. ground hoof, and 2 lbs. sulphate of potash per cubic yard of loam. *	2.1	3.0	4.0	5.2	6.2
C. 2. Control plus 0.25 per cent. caustic lime ...	2.0	3.2	4.0	5.0	6.3
C. 3. Control plus 0.5 per cent. caustic lime ...	1.8	2.7	3.4	5.2	6.0
C. 4. Control plus 1.0 per cent. caustic lime ...	1.6	3.5	4.0	5.0	6.0
C. 5. Control plus 2.5 per cent. caustic lime ...	1.1	2.7	3.2	4.3	5.3
C. 6. Control plus 5.0 per cent. caustic lime ...	1.6	2.9	3.7	5.1	6.1
C. 7. Control plus 10.0 per cent. caustic lime ...	1.2	2.5	3.5	4.8	5.6
				Total	41.5

* A cubic yard of heavy clay loam weighed
18.75 cwt.

Series D.—Effect of chalk (carbonate of lime).
(Heavy clay loam from Waltham Abbey).

	Total fruit to end of each month in lbs. per plant.				
	June.	July.	Aug.	Sept.	Oct.
D. 1. Control mixture of heavy clay loam plus 56 lbs. straw manure, 2 lbs. bone-meal, 2 lbs. bone-flour, 2 lbs. ground hoof, and 2 lbs. sulphate of potash per cubic yard.	1.4	3.6	4.3	5.6	6.8
D. 2. Control plus chalk equal to 0.25 per cent. caustic lime	1.7	3.0	3.8	5.3	6.0
D. 3. Control plus chalk equal to 0.5 per cent. caustic lime	1.5	2.8	3.7	4.7	5.9
D. 4. Control plus chalk equal to 1.0 per cent. caustic lime	1.3	3.1	3.8	5.0	5.8
D. 5. Control plus chalk equal to 2.5 per cent. caustic lime	1.1	2.5	3.1	4.3	4.8
D. 6. Control plus chalk equal to 5.0 per cent. caustic lime	1.4	2.2	3.1	4.1	5.6
D. 7. Control plus chalk equal to 10.0 per cent. caustic lime	1.8	3.6	4.7	5.4	5.8
				Total	40.7

Summary of Table I.

Averages of the series
in lbs. per plant.

Series A. plus C.—Light and heavy soils with lime ...	6.8
Series B. plus D.—Light and heavy soils with chalk ...	6.7
Series A. plus B.— Light soil with lime and chalk ...	7.7
Series B. plus D.— Heavy soil with lime and chalk ...	5.9

The light soil appears to be the better adapted to pot tomato requirements.

Table II.

Series E.—Experiments on the quantity of straw manure required for pot culture of tomatoes.

	Total fruit to end of each month in lbs. per plant.				
	June.	July.	Aug.	Sept.	Oct.
E. 1. Control mixture of light sandy loam from Station plus 8 lbs. lime, 2 lbs. bone-meal, 2 lbs. bone-flour, 2 lbs. ground hoof, and 2 lbs. sulphate of potash per cubic yard of loam	1.6	3.9	5.0	5.8	6.6
E. 2. Control plus 5.0 per cent. straw manure ...	2.4	4.2	5.4	6.0	6.7
E. 3. Control plus 10.0 per cent. straw manure...	2.3	3.8	4.9	5.6	6.5
E. 4. Control plus 20.0 per cent. straw manure...	1.7	3.6	5.1	5.9	6.7
E. 5. Control plus 30.0 per cent. straw manure...	1.8	3.5	4.5	4.9	5.9
E. 6. Control plus 40.0 per cent. straw manure...	2.0	3.5	4.8	5.6	6.7
E. 7. Control plus 50.0 per cent. straw manure...	2.2	4.3	5.4	6.4	7.4

Table III.

Series F.—Experiments with "Humogen" on pot tomatoes.

	Total fruit to end of each month in lbs. per plant.				
	June.	July.	Aug.	Sept.	Oct.
F. 1. Control mixture of light sandy loam from Station plus 8 lbs. lime, 2 lbs. bone-meal, 2 lbs. bone-flour, 2 lbs. ground hoof, and 2 lbs. sulphate of potash per cubic yard of loam	1.5	4.2	3.8	6.5	7.5
F. 2. Control plus 56 lbs. straw manure per cubic yard of loam	1.2	3.9	5.6	6.3	7.1
F. 3. Control plus "Humogen" at rate of 1 in 8 (1 to 7)	0.8	2.8	4.1	4.7	5.5
F. 4. Control plus "Humogen" at rate of 1 in 10 (1 to 9)	1.0	2.8	4.0	4.5	5.1
F. 5. Unsterilised loam and "Humogen" only at rate of 7 to 1 (1 in 8)	1.3	3.5	4.1	4.5	4.7
F. 6. Sterilised loam and "Humogen" only at rate of 7 to 1 (1 in 8)	1.3	3.7	4.1	4.5	4.7
F. 7. Unsterilised loam and "Humogen" only at rate of 9 to 1 (1 in 10)	1.6	3.6	4.0	4.1	4.2
F. 8. Sterilised loam and "Humogen" only at rate of 9 to 1 (1 in 10)	1.3	3.5	4.0	4.1	4.4

Cucumber Border Experiments.

The cucumber culture houses consist of three which are each 100 feet long by 13 feet wide, and two which are each 75 feet long by 13 feet wide, one of the latter being divided into two transversely, giving a total border length of 880 feet, and a total area of 0.1343 of an acre. The total number of plants grown in 1916 was 440, being planted 2 feet apart in the 18 experimental borders.

The total amount of fruit picked was 10.9 tons, equal to 81.2 tons per acre, the average per plant being 55.5 lbs.

677 flats* were sent to market of an average weight of 45 lbs. each when packed, consisting of 24 $2\frac{1}{2}$ dozens, 323 3 dozens, 261 $3\frac{1}{2}$ dozens, 48 4 dozens, and 21 crooks and smalls.

* Flats are baskets in which cucumbers are packed according to size, so that a specified number of dozens fills the basket when packed with hay and tissue paper in four layers. The internal dimensions of a flat are 21ins. by 15ins. by 9ins.

Top Dressings for Cucumber Borders, 1916.

Throughout the Series G. to Q. inclusive, top dressings were given every fortnight from March 21st to the end of the season, of exactly the same composition as the original borders in each case, no other fertilisers being added at any time. The amounts of each dressing were as follows:—

Series.	Top-dressing.
G. 1. & H. 1.	One barrow second spit loam, one barrow straw manure, and $1\frac{1}{2}$ lbs. lime to each set of 9 plants.
G. 2. & H. 2.	Half barrow top spit loam, half barrow second spit loam, one barrow straw manure, and $1\frac{1}{2}$ lbs. lime to each set of 9 plants.
G. 3. & H. 3.	Two barrows top spit loam, two barrows straw manure, and 3 lbs. lime to each set of 18 plants.
I. 1. & I. 3.	Four barrows loam, half barrow "Humogen," and 3 lbs. lime to each set of 12 plants.
I. 2. ...	One and a third barrows loam, one and a third barrows straw manure, and 2 lbs. lime to 12 plants.
K. ...	Eight barrows loam, 12 lbs. bone-meal, 12 lbs. hoof, and 6 lbs. lime to 36 plants.
L. 1. ...	Two barrows loam, 2 barrows straw manure, 3 lbs. lime, and $4\frac{1}{2}$ lbs. bone-meal to 16 plants.
L. 2. ...	Two barrows loam, two barrows straw manure, and 3 lbs. lime to 16 plants.
L. 3. ...	Two barrows loam, two barrows straw manure, 3 lbs. lime, and $2\frac{1}{2}$ lbs. hoof to 16 plants.
M. ...	Six barrows loam, six barrows straw manure, 9 lbs. lime, $4\frac{1}{2}$ lbs. hoof, and $4\frac{1}{2}$ lbs. bone-meal to 48 plants.
N. ...	Nine barrows loam, $4\frac{1}{2}$ barrows straw manure, and 9 lbs. lime to 48 plants.
O. ...	Nine barrows loam, $4\frac{1}{2}$ barrows straw manure, 9 lbs. lime, $4\frac{1}{2}$ lbs. bone-meal, and $4\frac{1}{2}$ lbs. hoof to 48 plants.
P. ...	Nine barrows loam, $4\frac{1}{2}$ barrows straw manure, $13\frac{1}{2}$ lbs. bone-meal, and 9 lbs. lime to 48 plants.
Q. ...	Nine barrows loam, $4\frac{1}{2}$ barrows straw manure, 9 lbs. lime, and $6\frac{1}{2}$ lbs. hoof to 48 plants.

Table IV.

Series G. and H.—Comparison of turf and second spit loam for cucumber borders.

	Total fruit in lbs. per plant to end of each month.							
	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
G. 1 & H. 1. Borders of equal parts second spit loam and straw manure, plus 1 lb. lime per yard run of border	0.3	11.6	24.7	34.6	44.5	52.0	59.2	60.6
G. 2 & H. 2. Borders of one part top spit loam, one part second spit loam, and two parts straw manure, plus 1 lb. lime per yard run of border	0.4	10.5	23.6	33.1	41.2	49.5	55.8	58.1
G. 3 & H. 3. Borders of equal parts top spit loam and straw manure, plus 1 lb. lime per yard run of border	0.4	11.5	24.3	33.8	42.6	50.1	57.4	60.0

Table V.

Physiological effects of light and heat on crop production of cucumbers.

	Total fruit in lbs. per plant to end of each month.							
	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
North warmer half-house. Average of three borders	0.8	13.6	25.5	34.1	41.5	48.6	55.2	57.0
South cooler half-house. Average of three borders	0.0	8.7	23.0	33.1	44.1	52.5	59.7	62.2

The north warmer end was earlier, but lighter in total crop; the south cooler end later, but heavier in total crop. The temperature records were continuous and show an average difference of 4° F. throughout the season between the two halves.

Table VI.

The results in Table V. are borne out by records of two other borders with identical treatment, one at the north end and one at the south end of a house, both on the same side.

	Total fruit in lbs. per plant to end of each month.							
	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
North warmer end	0.6	12.5	21.6	29.2	36.1	41.9	48.2	49.8
South cooler end	0.0	9.3	18.9	27.4	36.2	44.4	51.3	53.3

The temperature records were intermittent and show an average difference of 2° F. throughout the season between the two ends.

Table VII.

Experiment with "Humogen" on cucumbers.

	Total fruit in lbs. per plant to end of each month.							
	Mar.	Apl.	May.	June.	July.	Aug.	Sept.	Oct.
I. 1 & I. 3. Borders of loam and "Humogen" in the proportion of 8 to 1 (1 in 9), plus 1 lb. lime per yard run of border, Average of two borders	0.6	10.9	20.3	28.3	36.2	43.2	49.7	51.5
I. 2. Control border of equal parts loam and straw manure plus 1 lb. lime per yard run of border ...	0.5	12.6	23.0	29.7	37.6	43.0	47.8	49.3

Table VIII.

Series K.—Cucumber border without straw manure.

	Total fruit to end of each month in lbs. per plant.							
	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.
Border of loam plus 1 lb. lime, 2 lbs. bone-meal, and 2 lbs. ground hoof per yard run of border	0.7	10.2	20.0	26.3	33.0	37.3	42.9	44.0

Table IX.

Series L. and M.—Cucumber borders with 50 % straw manure.

	Total fruit to end of each month in lbs. per plant.							
	Mar.	Apl.	May.	June.	July.	Aug.	Sept.	Oct.
L. 1. Border of equal parts loam and straw manure, plus 1 lb. lime, and $1\frac{1}{2}$ lbs. bone-meal per yard run of border	0.6	9.4	19.9	26.1	31.6	35.0	38.6	39.2
L. 2. Control border of equal parts loam and straw manure, plus 1 lb. lime per yard run of border ...	1.1	13.6	24.4	32.1	38.6	43.0	46.1	46.7
L. 3. Border of equal parts loam and straw manure plus 1 lb. lime and $\frac{3}{4}$ lb. hoof per yard run of border	1.2	14.4	25.2	32.7	40.1	44.5	46.5	46.5
M. Border of equal parts loam and straw manure, plus 1 lb. lime $\frac{1}{2}$ lb. bone-meal, and $\frac{1}{2}$ lb. hoof per yard run of border	1.3	16.2	26.7	33.9	39.7	41.2	44.3	45.0

Table X.

Series N. O. P. and Q.—Cucumber borders with $33\frac{1}{3}\%$ straw manure.

	Total fruit to end of each month in lbs. per plant.							
	Mar.	Apl.	May.	June.	July.	Aug.	Sept.	Oct.
N. Border of two parts loam to one part straw manure, plus 1 lb. lime per yard run of border	1.1	15.7	27.4	33.8	38.9	43.4	47.0	47.4
O. Border of two parts loam to one part straw manure, plus 1 lb. lime, $\frac{1}{2}$ lb. bone-meal, and $\frac{1}{2}$ lb. ground hoof per yard run of border	1.4	15.7	27.7	34.7	40.8	45.8	49.8	50.1
P. Border of two parts loam to one part straw manure, plus 1 lb. lime, and $1\frac{1}{2}$ lbs. bone-meal per yard run of border	1.0	14.9	24.9	35.2	41.6	45.6	48.1	48.3
Q. Border of two parts loam to one part straw manure, plus 1 lb. lime and $\frac{3}{4}$ lb. ground hoof per yard run of border	0.9	16.5	26.3	35.1	41.4	46.6	49.5	49.7

Table XI.

Comparison of borders with 50 % and $33\frac{1}{3}\%$ straw manure respectively.
Average of four borders in each case.

	Total fruit to end of each month in lbs. per plant.							
	Mar.	Apl.	May.	June.	July.	Aug.	Sept.	Oct.
Borders with 50 per cent. straw manure	1.0	13.4	24.1	31.2	37.5	43.9	43.9	44.3
Borders with $33\frac{1}{3}$ per cent. straw manure	1.1	15.7	26.6	37.2	40.7	45.4	48.6	48.8
In favour of border with $33\frac{1}{3}$ per cent. straw manure	0.1	2.3	2.5	6.0	3.2	4.5	4.7	4.5

Tomato Border Experiments.

There are five tomato culture houses, each 100 feet long by 26 feet wide, giving a total area of 0.2984 of an acre.

The total fruit was 13 tons, equal to 43.6 tons per acre. The number of plants grown was 4,608, giving an average yield of 6.3 lbs. per plant.

The total number of strikes² sent to market was 2,390 consisting of 374 Pinks, 593 Pink and Whites, 47 Cross Pink and Whites, 1,107 Blues, 83 Whites, 160 Blue and Whites, and 26 Chats.

² Strikes are baskets holding 12 lbs. of fruit and graded according to size and quality from Pinks down to Chats.

Tomato Houses Nos. 1 and 2.

Damping Experiment. Series R. and S.

One house was partitioned off from the next one in order to carry out an experiment on the effect of overhead damping on the setting of the fruit. Four varieties were grown and compared with corresponding numbers of the same varieties in the next house which was not damped overhead. The damping was done in House 1 about 10 a.m. each day, and in order not to introduce any error due to the mechanical shaking of the plants while spraying, the plants in House 2 were slightly shaken at the same time each day. The original manurial treatment in each house was exactly the same as in Plot 1, Houses 3 and 4 (See below.)

One mulching of straw manure was given on May 30th, and from June 13th onwards a fortnightly top-dressing of 3.5 ozs. Special Tomato Fertiliser per square yard was applied (For analysis see Appendix).

Table XII.

House 1. Series R. House 2. Series S.
Damped. Not Damped.

Total fruit to end of each month in lbs. per plant.												
Variety. Series R. & S.	June.	July.	Aug.	Sept.	Oct.	Average per plant per house.	June.	July.	Aug.	Sept.	Oct.	Average per plant per house.
Balch's "Fill- basket."	0.9	5.3	5.9	6.3	7.8		1.3	4.8	6.4	7.4	8.7	
"Comet."	0.5	4.1	4.8	5.1	6.2		1.0	4.4	5.5	6.2	7.1	
Holmes's "Tucks- wood Favourite."	0.7	5.7	6.3	6.6	7.6		1.5	5.3	6.4	7.8	8.4	
Balch's "Ailsa Craig."	0.8	5.0	5.4	5.6	6.4		1.3	4.9	5.8	6.2	7.2	
						7.0						7.9

Tomato Houses Nos. 3 and 4.

These houses were each divided into 8 equal plots of 32 square yards, and on each plot 117 plants of the variety "Comet" were grown. The different treatments were as follows:—

- Plot 1. Standard manurial treatment consisting of 2 lbs. lime, 14 lbs. straw manure, $\frac{1}{2}$ lb. bone-meal, $\frac{1}{2}$ lb. bone-flour, $\frac{1}{2}$ lb. ground hoof, and $\frac{1}{2}$ lb. sulphate of potash per square yard.
- Plot 2. Half the treatment in Plot 1.
- Plot 3. Double the treatment in Plot 1.
- Plot 4. * Complete artificials, lime, basic slag, superphosphate, sulphate of ammonia, nitrate of soda, and sulphate of potash, equivalent in nutritive value to the materials given in Plot 2, plus 7 lbs. straw manure per square yard.
- Plot 5. * Complete artificials equivalent to Plot 2, but no straw manure.
- Plot 6. * Complete artificials equivalent to Plot 2, but omitting phosphate.
- Plot 7. * Complete artificials equivalent to Plot 2, but omitting nitrogen.
- Plot 8. * Complete artificials equivalent to Plot 2, but omitting potash.

Table XIII.

House No. 3. House No. 4. Houses Nos. 3 & 4.
Series T. Series U. Series T. & U.
Averages.

Total fruit to end of each month in lbs. per plant.

	June.	July.	Aug.	Sept.	Oct.	June.	July.	Aug.	Sept.	Oct.	June.	July.	Aug.	Sept.	Oct.
Plot No. 1.	0.5	2.9	4.1	4.8	5.5	1.0	3.8	4.8	5.7	6.2	0.8	3.4	4.5	5.3	5.9
Plot No. 2.	0.6	3.1	4.3	5.0	5.6	0.9	3.9	4.8	5.6	6.1	0.8	3.5	4.6	5.3	5.9
Plot No. 3.	0.7	2.8	4.2	4.8	5.5	0.8	3.3	4.8	5.3	5.8	0.8	3.1	4.5	5.1	5.7
Plot No. 4.	0.4	2.9	4.4	4.9	5.7	0.7	3.2	4.1	4.8	5.1	0.6	3.1	4.3	4.9	5.4
Plot No. 5.	0.4	2.4	3.5	4.1	4.7	0.6	3.0	4.0	4.6	5.1	0.5	2.7	3.8	4.4	4.9
Plot No. 6.	0.3	2.6	3.6	4.2	4.8	0.6	3.4	4.2	5.0	5.3	0.5	3.0	3.9	4.6	5.1
Plot No. 7.	0.4	2.9	4.1	5.0	5.6	0.8	3.4	4.6	5.3	5.8	0.6	3.2	4.4	5.2	5.7
Plot No. 8.	0.3	2.9	4.1	4.9	5.6	0.7	3.4	4.5	5.1	5.8	0.5	3.2	4.3	5.0	5.7

* The quantities given in Plots 4 to 8 were as follows:—

Plot 4. **Before planting.** 1 lb. lime, 7 lbs. straw manure, 0.4 lb. basic slag, and 0.1 lb. sulphate of potash per square yard.

After planting in four equal instalments. 0.2 lb. sulphate of ammonia, 0.2 lb. nitrate of soda, 0.5 lb. superphosphate, and 0.2 lb. sulphate of potash per sq. yard.

Plot 5. Same as Plot 4 with the omission of straw manure.

Plot 6. Same as Plot 4 omitting straw manure, basic slag, and superphosphate.

Plot 7. Same as Plot 4 omitting straw manure, nitrate of soda, and ammonium sulphate.

Plot 8. Same as Plot 4 omitting straw manure and sulphate of potash.

For analyses of various materials used see Appendix.

No mulching or top-dressing other than the above was given in the Series T. and U.

Tomato House No. 5.

Varieties and Cultivation and Management Experiments.

Twenty-five varieties were grown in this house, with two rows (18 plants) of each variety on each side. In order to compare the value of stopping with non-stopping one side of the house (Nos. V. 1 to 25 inclusive) was not stopped, while the other side (Nos. W. 1 to 25 inclusive) was stopped as usual at four trusses, other details of cultivation and management being equal in each series. The original manurial treatment was exactly the same as in Plot 1., Houses 3 and 4 (see above). A mulching of straw manure was given on May 31st, and from June 13th onwards fortnightly top-dressings of Special Tomato Fertiliser were given at the rate of 3.5 ozs. per square yard. It will be seen from the appended table that 19 out of the 25 varieties tried gave results in favour of non-stopping

Table XIV.

Non-stopped.

Stopped.

Total fruit to end of each month in lbs. per plant.

VARIETY.	Series.	June.	July.	Aug.	Sept.	Oct.	Series.	June.	July.	Aug.	Sept.	Oct.
Balch's "Gem"	V. 1	1.7	4.3	5.6	6.3	6.6	W. 25	1.8	4.4	5.6	6.3	7.0
Balch's "Ayrshire"	2	2.7	6.7	8.3	9.0	9.6	24	2.0	5.9	7.0	7.4	8.3
Balch's "Garrick"	3	1.8	5.5	7.3	8.3	8.8	23	1.7	5.5	6.9	7.5	8.3
Balch's "Jolly Boy"	4	1.5	4.5	5.8	6.7	7.0	22	1.3	4.4	5.1	5.7	6.0
Balch's "Water Baby"	5	1.6	4.7	6.1	6.8	7.1	21	0.9	3.9	4.9	5.3	5.8
Sutton's "Satisfaction"	6	1.2	4.4	5.6	6.3	6.7	20	1.1	4.1	5.0	5.3	5.7
Sutton's "Early Market"	7	1.1	4.9	6.3	7.0	7.2	19	1.3	4.4	5.3	6.0	6.6
Sutton's "Main Crop"	8	1.0	4.1	5.6	6.6	7.1	18	0.9	4.2	5.3	5.8	6.4
Sutton's "Best of All"	9	1.8	5.4	7.5	8.4	9.0	17	1.3	4.8	5.9	6.9	7.9
"Blaby"	10	1.6	4.1	5.6	6.6	7.5	16	1.8	4.0	4.9	5.8	6.6
Balch's "Ailsa Craig," Rochford's "Improved"	11	1.0	5.7	7.7	8.8	9.5	15	1.4	5.6	6.7	7.6	8.3
Paul's "No. 1"	12	1.0	4.3	6.0	6.7	7.2	14	0.9	4.5	5.5	6.2	6.7
Holme's "Seedling A"	13	1.0	3.0	4.0	4.8	5.0	13	0.9	3.4	4.2	4.8	5.3
Holme's "Seedling B"	14	0.6	3.8	5.0	5.8	6.1	12	0.6	3.9	4.8	5.5	6.0
Holme's "Seedling C"	15	0.9	3.7	5.0	5.6	5.9	11	1.1	4.4	5.1	5.8	6.3
Holme's "Seedling E"	16	1.0	4.6	5.7	6.5	7.1	10	1.0	4.7	5.8	6.7	7.2
Holme's "Seedling G"	17	1.5	5.1	6.5	7.2	7.5	9	1.5	4.8	5.7	6.5	7.2
"Early Dawn"	18	1.2	4.0	4.9	5.4	5.7	8	1.3	3.8	4.6	4.8	5.6
"Market King"	19	1.0	4.7	5.6	6.3	6.7	7	1.0	5.3	6.1	7.4	8.0
"Bengeworth Beauty"	20	0.6	3.9	4.7	5.3	5.8	6	0.7	4.0	4.5	5.2	5.6
Bide's "Recruit"	21	0.9	5.5	7.6	8.4	8.9	5	0.8	4.6	5.4	6.3	7.0
"Harpenden"	22	0.2	2.4	3.2	3.8	4.1	4	0.3	2.6	3.4	3.9	4.1
"Ailsa Craig" by Buck's "Tresco"	23	1.5	5.9	7.7	8.7	9.4	3	1.1	5.3	6.3	7.2	8.0
"Kondine Red" by "Tuckswood Favourite"	24	0.8	4.4	5.9	6.9	7.2	2	0.6	4.2	5.1	5.7	6.3
"Ailsa Craig" by "Hammerston's Romford"	25	1.4	6.5	8.1	9.4	10.2	1	1.0	6.3	6.8	7.8	9.0

Average 7.2.

Average 6.8.

Appendix.

Notes on the weather of the season 1916, from a grower's point of view.

The year 1916 will be long remembered by growers on account of the great quantity of rain, the small amount of direct sunlight, and the long dreary spring.

In January there was a short period of mild open weather, but this gave way to a cold rainy time which lasted on and off till the end of February, although not much snow or frost was recorded during these two months.

In March there were many alternating periods of bright sunny days and cold nights with dull moist periods. In the early part of the month the rainfall was heavy and on the night of the 28th there was one of the worst wind gales ever experienced in the district.

April opened in a genial manner and plants began to grow rapidly, but this did not last for long, and the month as a whole was dull, moist, and cold.

May and June were similar in character to April, and cucumber and tomato crops were difficult to manage because of the extremely rapid changes, dull moist periods giving way to hot bright sunny ones and causing the plants to flag badly. The result was that crops were much later than usual in maturing, growers generally complaining of a loss of a fortnight which was never regained.

During July and August dull moist periods were repeatedly followed by bright hot sunny ones with drying winds, and all growth was weak. Tomato "mildew" (*Cladosporium*) was difficult to control because the atmospheric conditions were not in the grower's favour. August was the wettest month of the year, over 1 inch of rainfall being recorded on the 18th, and nearly 1½ inches on the 29th.

September was the best month in the year. There was a good amount of sunshine with dry atmospheric conditions, which was of great value in ripening tomatoes. This lasted until the beginning of October when the dull cold weather returned with no improvement until the end of the year.

From a grower's point of view the weather of the whole year had very few good features.

Meteorological Records, 1916.

Month.	Rain.		Average outside Temperatures.	
	Total Fall. 5 inch Funnel Gauge.	No. of Rainy Days.	Day Maxm. °F.	Night Minm. °F.
	Inches.			
January	0.89	10	52.0	38.5
February	2.34	16	47.3	32.6
March	3.67	19	48.4	34.4
April	1.15	10	62.0	35.5
May	1.75	11	75.0	45.6
June	2.16	15	70.0	44.1
July	1.97	12	82.6	49.3
August	6.14	16	77.3	50.4
September	1.49	8	70.2	45.6
October	2.31	16	63.3	43.2
November	4.57	13	51.9	36.5
December	2.48	10	40.1	30.0
Total or Mean ...	30.92	156	61.7	40.5

Analyses of Materials and Fertilisers.

LIME.—Best Buxton Lump Lime. 98 per cent. CaO.

CHALK.—Best White Lump. 98 per cent. CaCO₃.

BASIC SLAG.—18 per cent. of Phosphates soluble in a 2 per cent. Citric Acid Solution, and with 80 per cent. fine meal passing 100 mesh sieve.

Fertiliser.	Nitrogen. Ammonia.		Phosphates. Soluble and Insoluble.		Potash pure.
	Equal to		Total.	Of which Soluble.	
Bone Meal	3.70	4.50	45.0	—	—
Bone Flour	0.82	1.00	60.0	—	—
Ground Hoof	13.94	17.00	—	—	—
Superphosphate	—	—	—	26	—
Nitrate of Soda	15.00	18.21	—	—	—
Sulphate of Ammonia	19.75	24.00	—	—	—
Sulphate of Potash	—	—	—	—	48.0
Special Tomato Fertiliser	4.12	5.00	23	14	3.0

Dates of Sowing, Potting, Planting, Picking, &c., 1916.

Crop.	Sown.	Pricked off.	Potted into 60's.	Potted into 32's.	Potted into 8's.	Planted out in borders.	Mulching.	First Top Dressing.	First Fruit Picking.	Last Fruit Picking.
Tomatoes in pots ...	Jan. 6	Jan. 17	Feb. 8	Mar. 14	April 9	—	—	June 13	May 31	Oct. 27
Tomatoes in borders ...	Jan. 6	Jan. 17	Feb. 9-10	—	—	Mar. 8-10	May 30-31	June 13	June 1	Oct. 30
Cucumbers in borders...	Jan. 7	Jan. 10	Jan. 14	Feb. 7	—	Feb. 16-18	—	Mar. 21-23	Mar. 24	Oct. 16

Analysis of soil of tomato houses. Rothamsted Laboratory. Dec. 4th, 1914.

Mechanical Analysis.	Per cent. on air dried sample.	Chemical Analysis.	Per cent. on air dried sample.
Fine Gravel above 1 m.m. ...	3.5	Nitrogen ...	.32
Coarse Sand 1—0.2 m.m. ...	24.4	Potash (K ₂ O) ...	.33
Fine Sand 0.2—.04 m.m. ...	22.4	" available* ...	.018
Silt .04—.01 m.m. ...	19.6	Phosphoric Acid (P ₂ O ₅) ...	.32
Fine Silt .01—.002 m.m. ...	11.1	" " available* ...	.080
Clay below .002 m.m. ...	4.7	" Sol. in 1 per cent. Citric Acid.	
Loss on solution in N/5 HCl ...	4.6		
Loss on ignition ...	8.58		

Bulletin No. 1.

Manuring for Tomatoes in War Time.

The following information is issued at a time when growers are thinking of preparations for next season's crops, in the hope that it may help to overcome some of the difficulties that beset them, due to the high price and non-availability of certain classes of manures and fertilisers.

At present the suggestions are confined to Winter Treatment of Tomato soils. Further suggestions as to top-dressing may be issued in the Spring.

The most active ingredients of all manures, whether natural or artificial, are nitrogen, phosphates, potash and lime. These are all necessary to form the life food of the plants, and it is proposed to show how they may be most advantageously obtained under present conditions.

Liming is the first operation, but if the soil effervesces with dilute Hydrochloric Acid (Spirit of Salt), there is no necessity to apply lime this year, unless it is required for cleansing purposes. The transport of lime at present is full of difficulties. If in doubt as to the lime requirements of your soil, send a sample to the Station.

Nitrogen, phosphates and potash, can be supplied to a certain extent in the form of straw manure, and where this is obtainable in quantity it forms the basis of most schemes of manuring. Many growers have to buy straw manure in large quantities at some considerable time before they are in the position to use it. Under these circumstances it is strongly recommended that the manure be kept under cover, and compacted as much as possible.

Where dung is dear or difficult to obtain, hoof and horn may be used to supply extra nitrogen.

Phosphates may be applied in the form of basic slag, bone-meal, or bone-flour. Dissolved bone compounds and superphosphates are difficult to obtain, and are not recommended under present conditions.

Potash is usually applied to Tomatoes in the form of sulphate of potash, but is at present unobtainable.

Straw dung contains from 12 to 15 lbs. of potash per ton, equal to from 20 to 27.75 lbs. of sulphate of potash. Where good growing has been practised in the past and liberal supplies of manures and fertilisers have been added, there need be no fear that the whole of the potash has been removed, and this can now be treated as a reserve and drawn upon for the benefit of the crop by liming the land. Potash being a soluble manure can be readily supplied in the form of a top dressing in the Spring if it should become available.

Tomato Soils may be considered to belong to one of the three following classes:-- heavy soils; light soils rich in organic matter; or light soils deficient in organic matter. The treatment for each would naturally vary, but it is hoped from the facts given that growers will be able to draw conclusions as to what is best suited to their own soil conditions.

Heavy Soils. Lime if necessary. See above. This lightens the soil and releases reserves of potash.

Basic slag is a good form of phosphate to use and should be applied as early as possible, either alone or in conjunction with bone-meal. Two tons of basic slag alone, or one ton of basic slag and half-a-ton of bone-meal per acre, are suitable dressings.

Straw manure should be dug in where available, as it has a good lightening effect on the soil, and supplies nitrogen, phosphates, and potash. Hoof and horn at rate of 6 to 8 cwts. per acre may be used in conjunction with basic slag and bone-meal where dung is difficult to obtain, but these will not have the lightening effect on the soil that dung has.

Light Soils rich in organic matter, or old borders. Lime if necessary for cleansing purposes, or where deficient. Basic slag may be used as under Heavy Soils, or half the quantity of steamed bone-flour. Straw manure can be used if the soil is not already too rich in organic matter, but it is left to the discretion of the grower as to whether it is desirable or necessary.

Hoof and horn should not be used on this type of soil.

Light Soils deficient in organic matter. Lime for cleansing or where deficient. Plenty of straw manure if available. Otherwise hoof and horn, in conjunction with bone-meal. These do not make the soil more retentive of water like dung does.

Manuring for Cucumbers. It is not at present possible to suggest any improvement on the existing methods of preparing Cucumber borders.

November 9th, 1916.

Bulletin No. 2.

Hints on the Culture of Early Potatoes under Glass.

The following information is issued at a time when it is hoped it may prove of use to growers who are willing to grow a crop of early potatoes this winter.

Varieties to plant. (a) First Earlys.

May Queen, Sharpe's Express, Ninety-fold—these are all kidney shaped, and white-fleshed. **May Queen** is very early, but is not so good a cropper as the other two.

Jersey Royal and **Sharpe's Express** are favourites with the Channel Island growers, but unless the former can be obtained in this country it is impossible to grow it as the export from Jersey is prohibited.

Epicure, Early Puritan—these are round white-fleshed sorts, **Epicure** being the better cropper of the two. Round sorts do not find so much favour in the market as kidney-shaped sorts.

Eclipse—really a second early, though often classed as a first early.

(b) Second Earlies.

Royal Kidney—useful on heavy soils.

British Queen—strong grower of good quality, but should not be planted in low-lying, damp situations.

Preparation of the Soil and Manuring.

Potatoes do best on a moderately light soil with good drainage, though many heavier soils may be used to advantage.

It will be best to choose houses in which the subsoil has been recently broken up, either by trenching, bastard trenching, or deep digging, other considerations being equal, as this will allow the roots to penetrate as far as necessary.

Lime should not be applied in large quantities to soil on which potatoes are to be grown, as it may induce scab, though this is not so likely under glass as in the open. Small quantities of lime will prove very beneficial in rich borders, say at the rate of $\frac{1}{4}$ -lb. caustic lime per square yard; and on heavy soils double this quantity can be given as it will lighten the soil and release reserves of potash. If the soil is distinctly alkaline to commence with only half the above quantities should be given, or replaced by equal amounts of chalk.

Potatoes are gross feeders and a liberal supply of soluble plant food is necessary for the production of a large crop. Where it can be obtained in quantity, straw manure is perhaps the best source of such food. This should be dug in at the rate of 15 tons per acre, as deep as possible consistent with the nature of the subsoil. The crop will respond to a complete dressing of artificials in addition to the dung if available. One cwt. of Sulphate of Ammonia has been proved to be as effective as a further five tons of straw manure. In its demand for potash the potato resembles the tomato, though of the two the latter is the more exacting. Where dung is applied at the rate of 15 tons per acre, the omission of potash is not serious if the soil be in good condition. In these circumstances, therefore, the grower need not be over anxious if he cannot get potash, as he can use one to two cwts. of Sulphate of Ammonia, and two to three cwts. of bone meal per acre in addition to the dung.

Although superphosphate has been proved to be beneficial in potato culture, it is not recommended at present unless the grower has some in stock, in which case it should be applied instead of the bone meal mentioned above, at the rate of four cwts. per acre. All the potash that can be got in the form of plant ashes should be applied. The amounts of artificials given above may be increased by 25 per cent., and although they will only give a small extra return in actual crop, yet the quality may be improved, always an important factor in early potatoes, and there will be a bigger residue left in the soil for the next crop.

Method of Planting.

Having obtained seed of the best variety procurable, they should be sprouted in boxes or pots, crown end up in a mixture of leaf mould, spent hops, or peat moss manure, mixed with a little well-rotted straw manure. The pots or boxes should be stacked close together and covered with damp mats for a day or two to induce the production of sprouts. The temperature should be maintained at 55° F. at night for the commencement. As soon as the sprouts are well started they should be disbudded to two at the crown end, and given plenty of light. When the two shoots are about one inch long and brownish green in colour, the sets should be planted out into moist warm borders so that no more watering than necessary is done at first. If the house is to be cleared of potatoes before planting the next crop, the potatoes can be planted in any of the following ways, whichever is the most convenient, viz.: 12 in. between the sets and 12 in. between

the rows; 8 in. between the sets and 18 in. between the rows; or 9 in. between the sets and 16 in. between the rows. Each of these methods requires exactly the same number of seed potatoes to plant an acre, i.e., nearly 40,000; assuming the average weight of a seed potato as one ounce, 22 cwts. of seed will be required. Anything from 15 to 22 cwts. of seed per acre can be planted under glass for early work, according to the distances decided on, and an average yield of three times the weight of seed planted may be expected. If tomatoes are to be planted before the potatoes are lifted, the latter should be planted so as to leave room for the tomato plants later between the rows. It will be convenient to make the rows of potatoes run the length of the houses, to avoid trouble with the pipes when earthing up. If possible the sets should be covered at planting time with a double handful of light compost. The distance at which the sets are planted is of great importance, for a crop too much crowded will be worth much less than one properly spaced. On the other hand the ground should be filled as closely as is possible, without detriment to the crop, as by wasting only a minute space in each breadth, or in the spaces between the sets, the total crop will be much less than the possible quantity. The guiding principle must be to allow to every separate plant ample room to spread and absorb the air and sunshine. If over crowded it bolts—in other words it produces all top and no bottom.

Under glass potatoes should be planted as shallow as possible.

In the Lea Valley it is not necessary to plant earlier than the end of January to obtain a crop ready for lifting in April.

Cultivation.

The potato, being a sub-tropical plant, will not stand frost. The ventilation should be carefully looked after, shutting up very early in the early winter months to box up the small amount of sunshine, and keeping sufficient heat going to keep out frost. Towards the end of the crop more ventilation should be given to prevent the top drawing, and a week or fortnight of extra heat will hasten the maturity. Given good open weather and a fair amount of sunshine a fair crop may be expected if allowed to mature, but the crop will be light if lifted before being matured, as is so often the case in the Channel Islands.

Just sufficient water to swell the tubers nicely should be given in the later stages, the watering being done in the morning to allow as much of the moisture as possible to escape before closing the houses for the night. It should be the aim of all growers to keep the soil frequently stirred during the period of growth, and all weeds should be kept down. The plants should be earthed up as soon as they are about six inches high, and a second earthing up should be given about a fortnight later. The drawing up of the soil to the plants promotes the growth of the tubers, prevents the soil getting too wet, and supports the haulm.

Diseases.

Potato crops under glass usually grow free from disease, and it is not anticipated that any spraying will be necessary. On the other hand all outdoor potatoes should always be sprayed.

December 18th, 1916.

An Introduction to the Interpretation of Experimental Results.

In all experiments with cucumbers, tomatoes, &c., under glass, there is an unavoidable source of error due to the fact that however careful one may be to insure uniform conditions of growth, there will still be variations among the individual plants in fruiting and every other characteristic, and the yields of two plots similarly treated will thus be liable to differ. When conditions vary as they do in plot experiments where watering, soil constitution, manuring, position in houses, &c., are not strictly uniform for each plot, these differences in yield will be increased. It is possible by an analysis of the results to calculate the odds for or against any result or any average being correct. The usual procedure is to state a margin of error such that the odds are even against the result differing from the true value by more than this amount. To this margin of error the name "probable error" is given. Suppose the yields of several plots are being compared, then if the yield of any single plot differs from the average by the amount of the probable error the odds that this difference is accidental are 1 to 1. The following table shows the odds against any one result being due simply to experimental error where the observed yield differs from the average yield by the amount stated in the first column. In determining the effect of manurial treatment on two plots of similar size, one treated and the other untreated, it must be remembered that we are comparing two results each of which is liable to an equal probable error. The effect of the treatment is given by the difference, which will be liable to a probable error of the square root of 2 times the probable error of either plot. The odds against the differences between the yields of two plots in terms of the probable error as stated in Column 2 are shown in Column 3.

Table of Odds.*

Differences from the mean in terms of the probable error.	Difference between two results in terms of probable error of each result.	Odds against such difference occurring under uniform conditions.
1.00 times the P.E.	1.41 times the P.E. per plot	1 to 1
1.25 " " "	1.76 " " " "	3 to 2
1.44 " " "	2.03 " " " "	2 to 1
1.71 " " "	2.41 " " " "	3 to 1
1.90 " " "	2.68 " " " "	4 to 1
2.00 " " "	2.83 " " " "	9 to 2
2.05 " " "	2.87 " " " "	5 to 1
2.50 " " "	3.53 " " " "	10 to 1
2.93 " " "	4.13 " " " "	20 to 1
3.00 " " "	4.24 " " " "	22 to 1
3.20 " " "	4.51 " " " "	30 to 1
4.00 " " "	5.66 " " " "	140 to 1
4.90 " " "	6.93 " " " "	1000 to 1
5.00 " " "	7.07 " " " "	1350 to 1

* From Supplement No. 7 to the Journal of the Board of Agriculture, November, 1911, page 25.

If the differences indicated in the middle column are found, the odds in the last column give the chances that they are due to the specific treatment, or, in other words that the results really mean something.

In all agricultural and horticultural experiments it is generally agreed to accept odds of 30 to 1 as practical certainty which means that the observed differences in yield between two plots due to any treatment must be at least 4.5 times the probable error of either plot before they are significant.

The experimental programme at the Station for tomatoes in the first year consisted mainly of standardising the soil in the five culture houses so that the error in this one direction might be determined. This was done by treating all the houses uniformly, growing the same number of each of fifteen varieties in each house, and carefully recording crop returns. (See Table I. First Annual Report, 1915.)

Using the figures obtained in this way the probable errors of the total yield per plot, the mean yield per plot, the mean yield per plant, and the yield per plant have been determined for several of the varieties grown.

Probable Error Determinations for Varieties of Tomatoes.

Variety.	No. of plants per plot.	P.E. of total yield per plot %.	P.E. mean yield per plot %.	P.E. mean yield per plant %.	P.E. actual yield per plant %.
		plus or minus.	plus or minus.	plus or minus.	plus or minus.
"Comet"	72	3.23	1.44	1.49	12.68
"Tuckswold Favourite"	72	3.41	1.53	1.53	13.02
"Hillside Comet" ...	72	4.14	1.85	1.82	15.47
"Fillbasket"	72	5.38	2.40	2.33	19.76
"Kondine Red"	144	4.69	2.10	2.13	25.55
"Romford"	72	7.02	3.14	3.01	26.24
"Jolly Boy"	72	7.33	3.28	3.30	28.00
"Ailsa Craig"	162	9.24	4.13	4.15	52.83

Total crop production depends on two factors of obvious commercial importance, viz. :—(1) the number of fruits which set and (2) the weight of the individual fruits. The uniformity of cropping and hence the magnitude of the probable error is entirely dependent on the interaction of these two factors and it is impossible to analyse the effect of either alone on the results obtained without special observations. With these reservations the figures obtained can be looked upon as indices of the purity of the varieties and the order in which they fall is largely corroborated by the opinion of growers, with the single exception of "Ailsa Craig," and it is interesting in this connection to note that the batches of plants (raised from local seed) were condemned by the growers as being a mixture of varieties. In the above Table only those figures obtained from equal sized plots are strictly comparable, which explains the reversal of the positions of "Fillbasket" and "Kondine Red" in Columns 2 and 5. The value for the probable error of the mean yield per plant is only true for plots containing the number of plants indicated and in order to determine the probable error for plots of any number of plants the figures in the last column must be divided by the square root of the number of plants per plot. The probable error of a field experiment has been shown to be plus or minus 5.0 per cent., so that for the varieties showing a probable error within this margin in Column 2 the figures in the last Column may be taken to be correct while the others are probably high. In conclusion the Director wishes to thank Mr. F. G. Gregory for his kind assistance in compiling this section.

